

CLAIMS

1. A differentially pumped vacuum system comprising apparatus having at least first and second chambers; and a vacuum pump for differentially pumping fluid from the chambers to generate a first pressure above 0.1mbar in the first chamber and a second pressure lower than the first pressure in the second chamber, the pump comprising at least first and second pump inlets each for receiving fluid from a respective pressure chamber and a plurality of pumping stages positioned relative to the inlets so that fluid received from the first chamber passes through fewer pumping stages than fluid from the second chamber, the inlets being attached to the apparatus such that at least 99% of the fluid mass pumped from the apparatus passes through at least one of the pumping stages of the pump.
2. A system according to Claim 1, wherein the first pressure is above 1 mbar.
3. A system according to Claim 1 or Claim 2, wherein each pumping stage comprises a dry pumping stage.
4. A system according to any preceding claim, wherein the apparatus comprises a third chamber, and the pump comprises a third inlet for receiving fluid from the third chamber to generate a third pressure lower than the second pressure in the third chamber, the pumping stages being arranged such that fluid entering the pump from the third chamber passes through a greater number of pumping stages than fluid entering the pump from the second chamber.

5. A system according to Claim 4, wherein the pump comprises at least three pumping sections, each comprising at least one pumping stage, for differentially pumping the first to third chambers.
- 5 6. A system according to Claim 5, wherein the pump comprises a first pumping section, a second pumping section downstream from the first pumping section, and a third pumping section downstream from the second pumping section, the sections being positioned relative to the inlets such that fluid entering the pump from the third chamber passes through the first, second and third pumping sections, fluid entering the pump from the second chamber passes through, of said sections, only the second and third pumping sections, and fluid entering the pump from the first chamber passes through, of said sections, only at least part of the third pumping section.
- 10
- 15 7. A system according to Claim 6, wherein at least one of the first and second pumping sections comprises at least one turbo-molecular stage.
- 20 8. A system according to Claim 6 or Claim 7, wherein both of the first and second pumping sections comprise at least one turbo-molecular stage.
- 25 9. A system according to any of Claims 6 to 8, wherein the third pumping section is positioned relative to the first and second pump inlets such that fluid passing therethrough from the second pump inlet follows a different path from fluid passing therethrough from the first pump inlet.
- 30 10. A system according to Claim 9, wherein the third pumping section is positioned relative to the first and second pump inlets such that fluid

passing therethrough from the first pump inlet follows only part of the path of the fluid passing therethrough from the second pump inlet.

11. A system according to any of Claims 6 to 10, wherein the third
5 pumping section comprises at least one molecular drag stage.

12. A system according to Claim 11, wherein the third pumping section
comprises a multi-stage Holweck mechanism with a plurality of
channels arranged as a plurality of helixes.

10 13. A system according to Claim 12, wherein the Holweck mechanism is
positioned relative to the first and second pump inlets such that fluid
passing therethrough from the first pump inlet follows only part of the
path of the fluid passing therethrough from the second pump inlet.

15 14. A system according to any of Claims 6 to 13, wherein the third
pumping section comprises at least one Gaede pumping stage
and/or at least one aerodynamic pumping stage for receiving fluid
entering the pump from each of the first, second and third chambers.

20 15. A system according to Claim 14 when dependent from Claim 12,
wherein the Holweck mechanism is positioned upstream from said at
least one Gaede pumping stage and/or at least one aerodynamic
pumping stage.

25 16. A system according to Claim 15, wherein the Holweck mechanism is
positioned relative to the first and second inlets such that fluid
entering the pump from the first pump inlet does not pass
therethrough.

17. A system according to any of Claims 14 to 16, wherein said at least one aerodynamic pumping stage comprises at least one regenerative stage.
- 5 18. A system according to any of Claims 14 to 17, wherein the third pumping section comprises at least one aerodynamic pumping stage and wherein, in use, the pressure of the fluid exhaust from the pump outlet is equal to or greater than 10 mbar.
- 10 19. A system according to any of Claims 4 to 18, wherein the apparatus comprises a fourth chamber located between the first and second chambers, and the vacuum pump comprises a fourth inlet for receiving fluid from the fourth chamber.
- 15 20. A system according to Claim 19, wherein the fourth inlet is positioned such that fluid entering the pump from the fourth chamber passes through, of said sections, only the third pumping section towards the pump outlet.
- 20 21. A system according to Claim 20, wherein the fluid entering the pump from the fourth chamber passes through a greater number of stages of the third pumping section than fluid entering the pump from the first chamber.
- 25 22. A system according to any preceding claim, wherein the pump comprises a drive shaft having mounted thereon at least one rotor element for each of the pumping stages.
- 30 23. A system according to any preceding claim, comprising a backing pump connected to the pump outlet such that, in use, at least 99% of the fluid mass pumped from the apparatus passes through both the vacuum pump and the backing pump.

24. A system according to any preceding claim, wherein the apparatus comprises a mass spectrometer.

5 25. A method of differentially evacuating a plurality of chambers of an apparatus, the method comprising the steps of providing a vacuum pump comprising at least first and second pump inlets each for receiving fluid from a respective chamber and a plurality of pumping stages positioned relative to the inlets so that fluid entering the pump
10 from the first inlet passes through fewer pumping stages than fluid entering the pump from the second inlet, attaching the inlets of the pump to the chambers such that, in use, at least 99% of the fluid mass pumped from the apparatus passes through at least one of the pumping stages of the pump, and operating the pump to generate a
15 first pressure above 0.1mbar in a first chamber and a second pressure lower than the first pressure in a second chamber.

26. A differentially pumped vacuum system comprising a plurality of pressure chambers; and a vacuum pump attached thereto and
20 comprising a plurality of pump inlets each for receiving fluid from a respective pressure chamber; and a plurality of pumping stages for differentially pumping the chambers; wherein a pumping stage arranged to pump fluid from the pressure chamber in which the highest pressure is to be generated comprises a Gaede pumping
25 stage or an aerodynamic pumping stage.

27. A system according to Claim 26, wherein said pumping stage comprises a regenerative stage.

30 28. A system according to Claim 26 or Claim 27, wherein said pumping stage comprises an aerodynamic pumping stage and wherein, in

- 20 -

use, the pressure of the fluid exhaust from the pump outlet is equal to or greater than 10 mbar.

29. A system according to any of Claims 26 to 28, wherein the plurality of
5 pressure chambers comprises a first chamber in which the highest pressure is to be generated and a second chamber in which a lower pressure is to be generated, and the plurality of inlets comprises a first inlet for receiving fluid from the first chamber and a second inlet for receiving fluid from the second chamber, the plurality of pumping
10 stages being positioned relative to the inlets so that fluid received from the first chamber passes through fewer pumping stages than fluid from the second chamber.

30. A system according to Claim 29, wherein the pressure in the first
15 chamber is above 0.1 mbar, preferably above 1 mbar.

31. A system according to Claim 29 or Claim 30, wherein the pump
comprises at least two pumping sections, each comprising at least
one pumping stage, for differentially pumping the first and second
20 chambers.

32. A system according to Claim 31, wherein the pump comprises a first
pumping section and a second pumping section downstream from
the first pumping section and comprising said pumping stage, the
25 sections being positioned relative to the inlets such that fluid entering the pump from the second chamber passes through the first and second pumping sections, and fluid entering the pump from the first chamber passes through at least said pumping stage of the second section.

33. A system according to Claim 32, wherein the first pumping section
30 comprises at least one turbo-molecular stage.

34. A system according to Claim 32 or Claim 33, wherein the second
pumping section is positioned relative to the first and second pump
inlets such that fluid passing therethrough from the second pump
inlet follows a different path from fluid passing therethrough from the
first pump inlet.

35. A system according to Claim 34, wherein the second pumping
section is positioned relative to the first and second pump inlets such
that fluid passing therethrough from the first pump inlet follows only
part of the path of the fluid passing therethrough from the second
pump inlet.

36. A system according to any of Claims 32 to 35, wherein the second
pumping section further comprises at least one molecular drag stage
located upstream from said pumping stage.

37. A system according to Claim 36, wherein the third pumping section
comprises, upstream from said pumping stage, a multi-stage
Holweck mechanism with a plurality of channels arranged as a
plurality of helixes.

38. A system according to Claim 37, wherein the Holweck mechanism is
positioned relative to the first and second pump inlets such that fluid
passing therethrough from the first pump inlet follows only part of the
path of the fluid passing therethrough from the second pump inlet.

39. A system according to Claim 37, wherein the Holweck mechanism is
positioned relative to the first and second inlets such that fluid
entering the pump from the first pump inlet does not pass
therethrough.

40. A system according to any of Claims 32 to 39, comprising a third pressure chamber, and wherein the pump comprises a third inlet for receiving fluid from the third chamber to generate a third pressure lower than the second pressure in the third chamber, the pumping stages being arranged such that fluid entering the pump from the third chamber passes through a greater number of pumping stages than fluid entering the pump from the second chamber.
41. A system according to Claim 40, wherein the pump comprises a third pumping section upstream from the second pumping section, the third sections being positioned relative to the third inlet such that fluid entering the pump from the third chamber passes through the first, second and third pumping sections.
42. A system according to Claim 41, wherein the third section comprises at least one turbo-molecular stage.
43. A system according to any of Claims 40 to 42, comprising a fourth chamber located between the first and second chambers, and wherein the vacuum pump comprises a fourth inlet for receiving fluid from the fourth chamber.
44. A system according to Claim 43, wherein the fourth inlet is positioned such that fluid entering the pump from the fourth chamber passes through, of said sections, only the first pumping section towards the pump outlet.
45. A system according to Claim 44, wherein the fluid entering the pump from the fourth chamber passes through a greater number of stages of the first pumping section than fluid entering the pump from the first chamber.

46. A system according to any of Claims 26 to 45, wherein the pump comprises a drive shaft having mounted thereon at least one rotor element for each of the pumping stages.
- 5 47. A method of differentially evacuating a plurality of chambers, the method comprising the steps of providing a vacuum pump comprising a plurality of pump inlets each for receiving fluid from a respective pressure chamber, and a plurality of pumping stages for differentially pumping the chambers; and attaching the pump to the
10 chambers such that a pumping stage for pumping fluid from the pressure chamber in which the highest pressure is to be generated comprises a Gaede pumping stage or an aerodynamic pumping stage.
- 15 48. A compound multi-port vacuum pump comprising first, second and third pumping sections, a first pump inlet through which fluid can enter the pump and pass through each of the pumping sections towards a pump outlet, a second pump inlet through which fluid can enter the pump and pass through only the second and third pumping
20 sections towards the outlet, an optional third pump inlet through which fluid can enter the pump and pass through only the third pumping section towards the outlet, and a fourth inlet through which fluid can enter the pump and pass through only part of the third pumping section towards the outlet.
- 25 49. A pump according to Claim 48, wherein at least one of the first and second pumping sections comprises at least one turbo-molecular stage.
- 30 50. A pump according to Claim 48 or Claim 49, wherein both of the first and second pumping sections comprise at least one turbo-molecular stage.

51. A pump according to any of Claims 48 to 50, wherein the third
pumping section is positioned relative to the second and fourth pump
inlets such that fluid passing therethrough from the second pump
5 inlet follows a different path from fluid passing therethrough from the
fourth pump inlet.

52. A pump according to Claim 51, wherein the third pumping section is
positioned relative to the second and fourth pump inlets such that
10 fluid passing therethrough from the fourth pump inlet follows only part
of the path of the fluid passing therethrough from the second pump
inlet.

53. A pump according to any of Claims 48 to 52, wherein the third
15 pumping section comprises at least one molecular drag stage.

54. A pump according to Claim 53, wherein the third pumping section
comprises a multi-stage Holweck mechanism with a plurality of
channels arranged as a plurality of helixes.

20 55. A pump according to Claim 54, wherein the Holweck mechanism is
positioned relative to the second and fourth pump inlets such that
fluid passing therethrough from the fourth pump inlet follows only part
of the path of the fluid passing therethrough from the second pump
25 inlet.

56. A pump according to any of Claims 48 to 55, wherein the third
pumping section comprises at least one Gaede pumping stage
and/or at least one aerodynamic pumping stage.

30 57. A pump according to Claim 56 when dependent from Claim 54,
wherein the Holweck mechanism is positioned upstream from said at

least one Gaede pumping stage and/or at least one aerodynamic pumping stage.

58. A pump according to Claim 57, wherein the Holweck mechanism is
5 positioned relative to the second and fourth pump inlets such that fluid entering the pump from the fourth pump inlet does not pass therethrough.
59. A pump according to any of Claims 56 to 58, wherein said at least
10 one aerodynamic pumping stage comprises at least one regenerative stage.
60. A pump according to any of Claims 57 to 59, wherein the third
15 pumping section comprises at least one aerodynamic pumping stage and wherein, in use, the pressure of the fluid exhaust from the pump outlet is equal to or greater than 10 mbar.
61. A pump according to Claim 60, wherein the third inlet is positioned
20 such that fluid entering the pump therethrough passes through, of said sections, only the third pumping section towards the pump outlet.
62. A pump according to Claim 61, wherein the fluid entering the pump
25 through the third inlet passes through a greater number of stages of the third pumping section than fluid entering the pump through the fourth inlet.
63. A pump according to any of Claims 48 to 62, comprising a drive shaft
30 having mounted thereon at least one rotor element for each of the pumping sections.

64. A differentially pumped vacuum system comprising a plurality of chambers and a pump according to any of Claims 48 to 63 for evacuating each of the chambers.